Annual Reports :: Year 6 :: Pennsylvania State University

Project Report: Modeling early atmospheric composition and climate_Kasting

Project Investigator:	James Kasting

Project Progress

Kasting spent 8 months of this year on sabbatical at JPL/Caltech working with Vikki Meadows' NAI group. I will describe those efforts separately as part of Vikki's report. My work with Penn State was divided into three parts: 1) coupled ecosystem/atmosphere modeling of the Archean Earth with my graduate student, Pushker Kharecha, 2) modeling of Snowball Earth with climate modeler David Pollard, and 3) modeling of BIF deposition with my graduate student, Shawn Goldman. In Project 1, we showed that an anaerobic ecosystem on the early Earth should have produced methane at approximately the same rate as today's combination aerobic/anaerobic ecosystem. This strengthens the argument that methane could have been an important factor in warming the climate of early Earth and offsetting the fainter young Sun. In project 2, we showed that "thin–ice" solutions can be found in the tropics, either globally or locally, despite the flow of sea ice from the poles to the equator. This provides a possible explanation for how photosynthetic algae and other light–dependent organisms survived the Snowball Earth episodes of the Late Proterozoic. In Project 3, we made a preliminary attempt to show that hematite–rich banded iron–formations (BIFs) could have formed in an anoxic environment. We argued that H_2 consumption by iron–reducing bacteria could have kept oxygen fugacities in iron–rich sediments below the crossover point between hematite and magnetite.

Highlights

- We showed that methane should have been produced by an anaerobic Archean ecosystem at approximately the same rate that it is generated today.
- We showed that thin ice may have existed within the tropics during Snowball Earth episodes. This may explain how photosynthetic algae were able to make it through these catastrophic episodes.

Roadmap Objectives

- **_Objective No. 1.1:_** Models of formation and evolution of habitable planets

- ***Objective No. 4.1:*** Earth's early biosphere
- ***Objective No. 4.2:*** Foundations of complex life

Mission Involvement

Mission Class*	Mission Name (for class 1 or 2) OR Concept (for class 3)	Type of Involvement**
2	TPF	Background Research

* Mission Class: Select 1 of 3 Mission Class types below to classify your project:
1. Now flying OR Funded & in development (e.g., Mars Odyssey, MER 2003, Kepler)
2. Named mission under study / in development, but not yet funded (e.g., TPF, Mars Lander 2009)
3. Long–lead future mission / societal issues (e.g., far–future Mars or Europa, biomarkers, life definition)

** Type of Involvement = Role / Relationship with Mission
Specify one (or more) of the following: PI, Co–I, Science Team member, planning support, data analysis, background research, instrument/payload development, research or analysis techniques, other (specify).

Cross Team Collaborations

As mentioned above, I spent the entire winter on sabbatical visiting Vikki Meadows' NAI group out at JPL/Caltech. Many of my Penn State projects overlap with their project.